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October 1989

Cold heading and cold extruding steels
Technical delivery conditions for case hardening steels

DIN 1654 Part 3

Kaltstauch- und Kaltfließpreßstähle; technische Lieferbedingungen für Einsatzstähle

Supersedes March 1980 edition.

In keeping with current practice in standards published by the International Organization for Standardization (ISO), a comma has been used throughout as the decimal marker.

The clauses and subclauses marked • give specifications which are to be agreed upon at the time of ordering, those marked •• give specifications which are optional and may be agreed at the time of ordering.

1 Field of application

This standard specifies case hardening steels with diameters from 2 to 100 mm, which should preferably be used for cold heading and cold extruding. It is to be applied in conjunction with DIN 1654 Part 1.

2 Concepts

See DIN 1654 Part 1.

3 • Dimensions and limit deviations

See DIN 1654 Part 1.

4 Mass

See DIN 1654 Part 1.

5 Designation and ordering

See DIN 1654 Part 1.

6 Steel grades

See DIN 1654 Part 1.

7 Requirements

7.1 Manufacturing process

See DIN 1654 Part 1.

7.2 Treatment condition of material on delivery

The steel shall normally be supplied in one of the treatment conditions listed in table 1.

7.3 Chemical composition, mechanical properties and hardenability

Table 1 summarizes combinations of usual treatment conditions of the material on delivery, product forms and requirements regarding chemical composition, mechanical properties and hardenability.

•• Unless otherwise agreed, the requirements given in column 5 of table 1 shall apply for the relevant treatment condition of the material on delivery and for the particular product form.

•• For orders to requirement class H, which only relates to alloy steels, the requirements regarding hardenability specified in table 5 shall also apply.

7.3.1 The chemical composition as determined by ladle analysis shall be as specified in table 2.

7.3.2 The amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified for the ladle analysis shall be as given in table 3.

7.3.3 The mechanical properties of steel in the treatment condition in which it is usually supplied shall be as specified in table 4.

7.3.4 The hardness values specified in table 5 may generally be assumed as applying to steels as covered in this standard under the test conditions specified in DIN 1654 Part 1.

•• If the hardness values specified in table 5 are to apply as a requirement, letter H shall be added to the material designation or material number for the steel when ordering.

7.3.4.1 •• Narrower hardenability bands may be agreed at the time of ordering, as specified in footnote 1 to table 5 and shown in figures 1a to 1e. Where a narrower hardenability band with respect to the upper or lower limiting curve is required, the symbol HH or HL shall be added to the relevant material designation or material number when ordering.

7.4 Microstructure

See DIN 1654 Part 1.

7.5 Surface condition and soundness

See DIN 1654 Part 1.

7.6 Decarburization

See DIN 1654 Part 1.

7.7 Separation of products by casts

See DIN 1654 Part 1.

Continued on pages 2 to 8

8 ●● Testing

See DIN 1654 Part 1.

9 Marking

See DIN 1654 Part 1.

10 Heat treatment and further processing

10.1 The information given in clause 10 of DIN 1654 Part 1, October 1989 edition, shall be taken into account.

10.2 The quenching temperatures for the end quench test shall be as given in table 5.

10.3 Guideline values for temperatures and examples of usual heat treatment stages in case hardening are given in appendix A of DIN 17 210, September 1986 edition.

11 Complaints

See DIN 1654 Part 1.

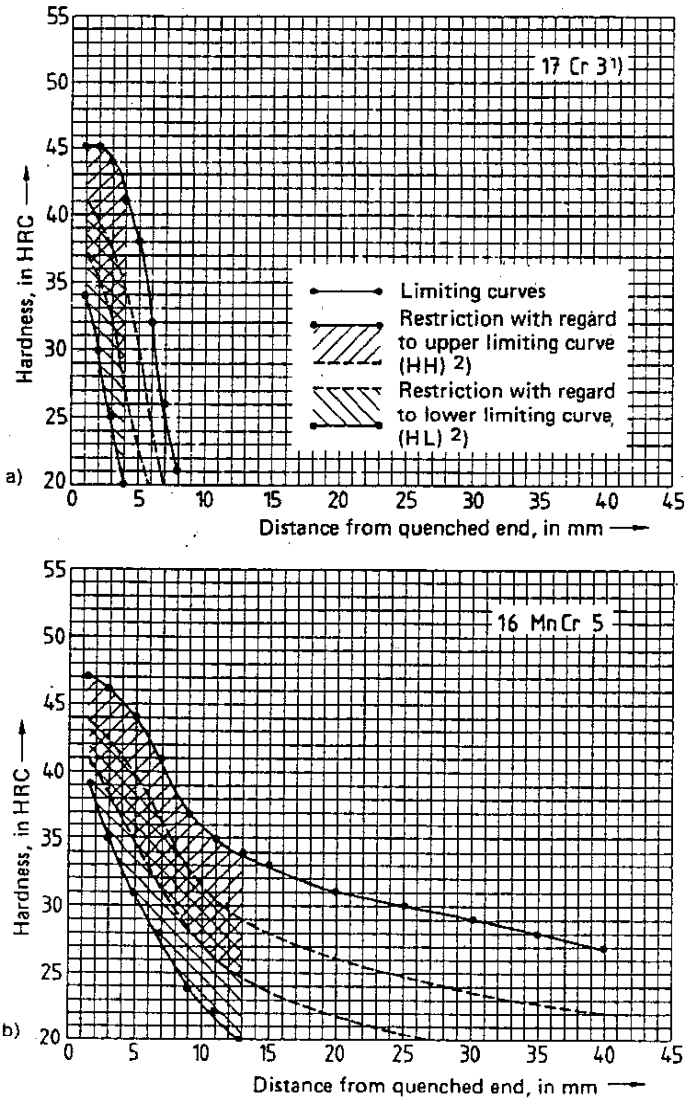
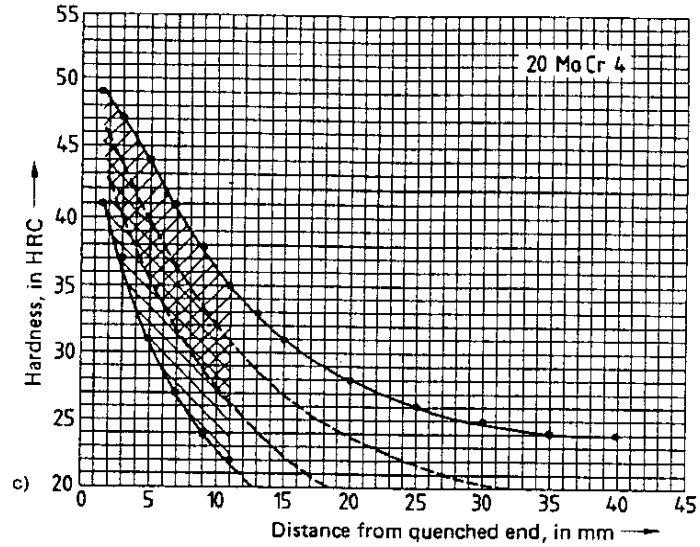
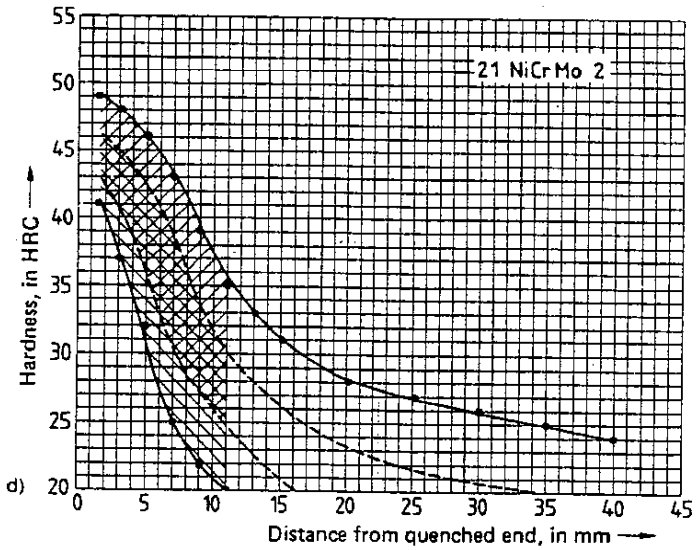


Figure 1. Hardenability bands for Rockwell C hardness determined by the end quench test

1) It should be noted that, when hardness test indentations are made at 1 mm intervals in this material at a hardness of less than 30 HRC, results will be affected by interaction between the indentations.

2) The restricted hardenability bands shall apply only up to the distance from the quenched end for which a hardness value is specified for the lower limiting curve; for greater distances, the restricted bands should be taken for guidance.





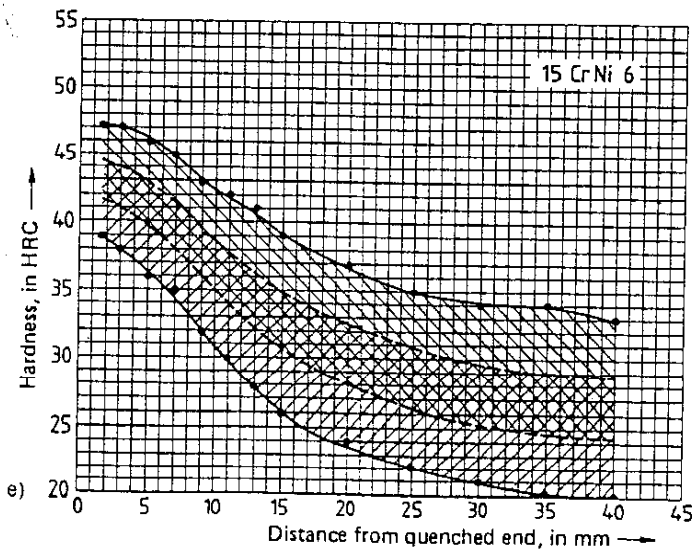


Figure 1 (continued).

Table 1. **Treatment conditions and product forms in which steel is usually supplied and associated requirements as specified in tables 2 to 5**

No.	1		2	3	4	5			6		
1	Treatment condition of material on delivery		Product form			Requirement class					
						Unless otherwise agreed [1]			H [2] (see subclause 7.3.4)		
		Symbol	Hot rolled steel bars	Wire rod	Drawn products	The following requirements given in tables 2 to 5 shall apply:					
						5.1	5.2		6.1	6.2	6.3
2	Untreated [3]	No symbol, or U	X	X	–	Chemical composition as in tables 2 and 3.	–		As in columns 5.1 and 5.2.		Hardenability as in table 5.
3	Spheroidized	GKZ	X	X	–		Mechanical properties as in table 4,	column 2			
4	Spheroidized and peeled	GKZ + SH	X	–	–			column 2			
5	Cold drawn and spheroidized	K + GKZ	–	–	X			column 3			
6	Cold drawn and spheroidized and slightly cold redrawn (with a reduction in cross section of 3 %, for example)	K + GKZ + K	–	–	X			column 4			
7	•• If a treatment condition other than those given in lines 2 to 6 is required, this shall be specified in uncoded form in the order; in such cases, the product form and the requirements shall be given in the order.										

1) The hardness values given in table 5 are to be regarded as guideline values in this case (see subclause 7.3.4).

2) Applies only to alloy steel. Letter H shall be specified in the order.

3) Applies mainly for steel supplied to drawing mills.

Table 2. **Chemical composition (ladle analysis)**

Steel grade		Percentage by mass[1], [2]							
Material designation	Material number	C	Si max.	Mn	P max.	S max.	Cr	Mo	Ni
Cq 15	1.1132	0,12 to 0,18	0,40	0,30 to 0,60	0,035	0,035	–	–	–
17 Cr 3 [3]	1.7016 [3]	0,14 to 0,20	0,40	0,40 to 0,70	0,035	0,035	0,60 to 0,90	–	–
16 MnCr 5 [3]	1.7131 [3]	0,14 to 0,19	0,40	1,00 to 1,30	0,035	0,035	0,80 to 1,10	–	–
20 MoCr 4 [3]	1.7321 [3]	0,17 to 0,22	0,40	0,70 to 1,00	0,035	0,035	0,30 to 0,60	0,40 to 0,50	–
21 NiCrMo 2 [3]	1.6523 [3]	0,17 to 0,23	0,40	0,65 to 0,95	0,035	0,035	0,40 to 0,70	0,15 to 0,25	0,40 to 0,70
15 CrNi 6 [3]	1.5919 [3]	0,14 to 0,19	0,40	0,40 to 0,60	0,035	0,035	1,40 to 1,70	–	1,40 to 1,70

1) Elements not listed in this table shall not be deliberately added to the steel except for finishing the cast, without the purchaser's approval. In cases of doubt, the limits given in EN 10 020 shall apply.

2) Except for phosphorus and sulfur, minor deviations from the limits specified for the ladle analysis are permitted if restricted hardenability bands in the end quench test have been ordered (see footnote 1 to table 5); the deviations shall, however, not exceed the values specified in table 3.

3) The values for the chemical composition of this steel are identical with those given in DIN 17 210.

Table 3. **Amounts by which the chemical composition as determined by product analysis may deviate from the limiting values specified in table 2 for the ladle analysis**

Element	Maximum permissible percentage by mass as determined by ladle analysis	Maximum deviations in the product analysis from the limiting values specified for the ladle analysis[1]), as a percentage by mass
C	≤ 0,23	0,02
Si	≤ 0,40	0,03
Mn	≤ 1,00 > 1,00 ≤ 1,30	0,04 0,05
P	≤ 0,035	0,005
S	≤ 0,035	0,005
Cr	≤ 1,70	0,05
Mo	≤ 0,30 > 0,30 ≤ 0,50	0,03 0,04
Ni	≤ 1,00 > 1,00 ≤ 1,70	0,03 0,05

1) If a number of product analyses are to be carried out, the deviations shown by one element within one cast shall lie either only above the upper limit or below the lower limit of the range specified for the ladle analysis.

Table 4. **Mechanical properties[1]) of steels in the treatment condition in which they are usually supplied*)**

1		2		3		4	
Steel grade		Treatment condition[2]) GKZ or GKZ + SH		K + GKZ		K + GKZ + K	
Material designation	Material number	R_m N/mm² max.	Z % min.	R_m N/mm² max.	Z % min.	R_m N/mm² max.	Z % min.
Cq 15	**1.1132**	460	65	460	65	490	65
17 Cr 3	**1.7016**	520	60	500	61	520	61
16 MnCr 5	**1.7131**	550	60	530	62	550	62
20 MoCr 4	**1.7321**	550	60	530	62	550	62
21 NiCrMo 2	**1.6523**	590	60	570	62	590	62
15 CrNi 6	**1.5919**	600	59	580	61	600	61

*) The values are provisional and may have to be corrected in the light of new findings.

1) *R_m is the tensile strength and Z is the reduction in area after fracture.*

2) See subclause 7.2.

Table 5. **Limiting values of Rockwell C hardness determined in the end quench test**[1], [2]
(Hardness values not given in this table can be obtained from figures 1a to 1e by interpolation.)

Steel grade		Hardness temperature for end quench test, in °C	Limits of harden-ability band	Hardness, in HRC, at a distance from quenched end, in mm												
Material designation	Material number			1	2	3	4	5	6	7	8	9	10	11	13	15
17 Cr 3	1.7016	880	Maximum	45	45	44	41	38	32	26	21	–	–	–	–	–
			Minimum	34	30	25	20	–	–	–	–	–	–	–	–	–
				Hardness, in HRC, at a distance from quenched end, in mm												
				1,5	3	5	7	9	11	13	15	20	25	30	35	40
16 MnCr 5	1.7131	870	Maximum	47	46	44	41	37	35	34	33	31	30	29	28	27
			Minimum	39	35	31	28	24	22	20	–	–	–	–	–	–
20 MoCr 4	1.7321	910	Maximum	49	47	44	41	38	35	33	31	28	26	25	24	24
			Minimum	41	37	31	27	24	22	–	–	–	–	–	–	–
21 NiCrMo 2	1.6523	925	Maximum	49	48	46	43	39	35	33	31	28	27	26	25	24
			Minimum	41	37	32	25	22	20	–	–	–	–	–	–	–
15 CrNi 6	1.5919	860	Maximum	47	47	46	45	43	42	41	39	37	35	34	34	33
			Minimum	39	38	36	35	32	30	28	26	24	22	21	20	20

1) •• For the steels specified, a hardenability band as determined in the end quench test, restricted to two thirds of the original bandwidth with respect to either the upper or the lower limiting curve (see figures 1a to 1e) may be agreed at the time of ordering. If a restriction in the hardenability band with respect to the upper limiting curve is required, symbol HH, and if a restriction in the hardenability band with respect to the lower limiting curve is required, symbol HL shall be specified in the order.

2) The limiting values of Rockwell C hardness are identical with those given in DIN 17210.

Standards referred to

DIN 1654 Part 1	Cold heading and cold extruding steels; technical delivery conditions; general
DIN 17 210	Case hardening steels; technical delivery conditions
EN 10 020	Classification of steel grades

Previous editions

DIN 1654: 05.43, 08.54; DIN 1654 Part 3: 03.80.

Amendments

The following amendments have been made to the March 1980 edition.

a) Steel grade 17 Cr 3 (1.7016) has been substituted for grade 15 Cr 3 (1.7015).

b) The specifications regarding chemical composition and hardenability have been brought into line with DIN 17 210.

c) The specifications regarding the maximum permitted content of oxidic nonmetallic inclusions have been quantified.

d) The specifications regarding mechanical properties of steel in the treatment conditions in which it is usually supplied have been revised.

e) Guideline values for the mechanical properties of blank hardened reference test pieces are no longer included.

f) The standard has been editorially revised; requirement classes are no longer specified.

g) A reference has been made to DIN 17 210 for guideline values regarding heat treatment.

Explanatory notes

See DIN 1654 Part 1.

International Patent Classification

C 22 C 38/00
G 01 N 33/20